"RSA-ANP-SSD" Spillover Effect Evaluation Model and Its Empirical Study about Strategic Emerging Automation Industry

Taking Intelligent Logistics Industry In Hunan as Example

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Abstract

This paper presents a new "RSA-ANP-SSD" combination weighting model which can not only meet the preference of decision makers, but also can reduce their subjectivity, and then, it has established the Strategic Emerging Automation Industry spillover effect evaluation index system and built two level fuzzy comprehensive evaluation model of China's strategic emerging automation industries, thus providing a useful tool of analysis and decision support for the formulation and implementation of our nation's development strategy of strategic emerging automation industries

Keywords

"RSA-ANP-SSD" Combination Weighting; Strategic Emerging Automation Industry; Spillover Effect; Evaluation

Introduction

Accelerating the development of Strategic Emerging Automation Industry is not only a major strategy deploy made by the Party Central Committee and the State Council, but also a major strategic choice made by many developed countries to seize the commanding point in the future economic development after the international financial crisis. The development of Strategic Emerging Automation Industry directly concerns the future of the Chinese nation and its long-term competitiveness, therefore the research on it is of great significance. Hunan is at the initial stage of the middle-term industrialization. Its industrial structure is unreasonable, the scale of the industries is small, and its economic development mode is comparatively extensive. Besides, the advantage of its industry competitiveness is not clear, it also lacks Strategic Emerging Automation Industry bases and enterprises that have strong core competitiveness. In order to ensure the healthy development of strategic emerging automation industries in Hunan, to complete the pilot task of the construction of national resource-conserving and environment friendly society in Hunan province, Hunan provincial government have already developed a overall strategy of "resource-conserving and environment friendly" and "new industrialization, new urbanization, farming modernization, information", as well as the grand plan to develop Strategic Emerging Automation Industry. However, how to develop Hunan Strategic Emerging Automation Industry is still a hot and difficult point of the research of theoretical and business circles.

At present, according to the existing documents, the research on the development of Strategic Emerging Automation Industry is mainly concentrated on the connotation definition, strategy and development path of the strategic emerging automation industries and some other aspects. While the research on the problem of overflow, is mainly concentrated on the intra industry spillover and inter industry spillover. This paper mainly studies the spillover effect of the Strategic Emerging Automation Industry. The review of the related documents on industry spillover effects can tell us that the first study of intra industry spillover was made by Marshall , and it was improved by Arrow and Romer .The continuation of the intra industry spillover is called MAR overflow. Another overflow mode , which came from the Jacobs' research on the overflow of the local diversified industries at the end of the 1960s, is known as Jacobs overflow. She believed diversified industrial structure is more conducive to the local competitiveness and innovation.

By contrast, MAR overflow is in line with local clusters, while Jacobs overflow in line with city agglomeration. They are important conceptions that explain the spatial agglomeration and city development power . MAR theory believes regional competition is not conducive to innovation and economic growth, while monopoly does. The Jacobs theory is the opposite. It thinks regional competition can finally promote the economic growth through stimulating the innovation of the enterprises. Porter proposed a similar MAR externality and Porter externality theory. He thinks that knowledge can stimulate economic growth only when it overflows in special aggregation industries. In the 1990s, Glaser and Henderson study the overflow effect for the first time by using empirical methods. Documents study foreign investment enterprises (FDI) bring local enterprises knowledge / technology innovation; Documents study international trades that bring enterprise technology innovation and so on. Based on the research of the Strategic Emerging Automation Industry overflow effect, this paper has proposed a new" RSA-ANP-SSD" combination weighting model, established a evaluate quota system on the Strategic Emerging Automation Industry overflow effect, constructed two level fuzzy comprehensive evaluation model, finally conduct a empirical research on this model, thus providing a useful tool of analysis and decision support for the formulation and implementation of our nation's development strategy of strategic emerging automation industries.

Analysis Framework of Model Structure

The evaluation model is generally divided into two parts, one part is the "RSA-ANP-SSD" combination weighting, another part is the two level fuzzy comprehensive evaluation of our nation's Strategic Emerging Automation Industry overflow effect. "RSA-ANP-SSD" is a combination weighting method that combines subjective and objective weighting. Its specific analytical framework is in Figure 1.

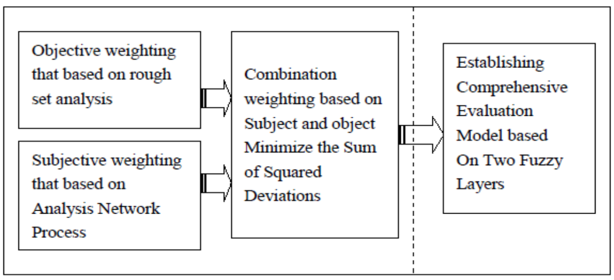

FIG. 1 MODELS FRAMEWORK THE OVERALL STRUCTURAL ANALYSIS

"RSA-ANP-SSD" Combination Weighting Theory

Objective Weighting That Based on Rough Set Analysis

Rough set theory is proposed by Poland Z Pawlak in 1982, which has a unique advantage in dealing with incomplete data and imprecise data. Suppose $s = (U, A, V, f)$ is an information system built by collecting a large amount of historical average sample. If $P \subseteq A, U / IND(P) = \{x_1, x_2, \ldots, x_n\}$, then the information content of knowledge P is defined as:

$$I(P) = \sum_{i=1}^{n} \frac{|Xi|}{|U|}\left[1 - \frac{|Xi|}{|U|}\right] = 1 - \frac{1}{|U|^2}\sum_{i=1}^{n} |Xi|^2$$

In the formula, $|X|$ stands for the cardinality of a set; $\frac{|X_i|}{|U|}$ represents the probability of equivalence class Xi in U. The importance of Index $c \in C$ in the index system C is as follows:

$$Sig_{C-\{c\}}(c) = I(C) - I(C - \{c\})$$

When $C = \{c\}$, use $Sig(c)$ to represent $Sig_\phi(c)$:

$$Sig(c) = Sig_\phi(c) = I(C) - I(\phi) = I(\{c\})$$

In the formula, $U / IND(\phi) = \{U\}, I(\phi) = 0$.

Therefore, the importance of the index $c \in C$ in the index system C can be measured by the data that result from the change of the information content which is caused by removing c from C. Thus, we can get the weighing of index $c \in C$, $C = \{c_1, c_2, \ldots, c_n\}$.

$$w_i = \frac{Sig_{C-\{c_i\}}(c)}{\sum_{j=1}^{n} Sig_{C-\{c_j\}}(c_j)} = \frac{I(C) - I(C - \{ci\})}{nI(C) - \sum_{j=1}^{n} I(C - \{c_j\})}$$

Therefore, the weighing of $c \in C$ can be calculated.

Subjective Weighting That Based on Analysis Network Process

Assuming determining matrix is A,

$$A = (a_{ij})_{m \times n}$$

Testing its consistency, and calculating random consistency ratio CR:

$$CR = \frac{CI}{RI}$$

If CR <0.1, then the expert judgments satisfied the conformance requirements matrix, or need to re-adjust after the test, until it meets CR <0.1 so far.

Based on the consistency comparison matrix, to calculate $(w_{i1}^{(ji)}, w_{i2}^{(ji)}, \wedge, w_{ini}^{(ji)})'$ by the eigenvalue method and Wij is:

$$w_{ij} = \begin{bmatrix} w_{i1}^{(j1)} & w_{i1}^{(j2)} & \dots & w_{i1}^{(jn_i)} \\ w_{i2}^{(j1)} & w_{i2}^{(j2)} & \dots & w_{i2}^{(jn_i)} \\ \dots & \dots & \dots & \dots \\ w_{in_i1}^{(ji)} & w_{in_i}^{(ji)} & \dots & w_{in_i}^{(ji)} \end{bmatrix}$$

Corresponds to network layer B_s, the super matrix is W, there are:

$$w = \begin{bmatrix} w_{11} & w_{12} & \dots & w_{1N} \\ w_{21} & w_{22} & \dots & w_{2N} \\ \dots & \dots & \dots & \dots \\ w_{N1} & w_{N2} & \dots & w_{NN} \end{bmatrix}$$

Elements of the weighted super matrix W, we have:

$$w = (\overline{w_{ij}}), \overline{w_{ij}} = a_{ij} w_{ij}, \quad i = 1, 2, \wedge, N; \; j = 1, 2, \wedge, N$$

W is the weighted super-matrix, the column is 1, it is also called random matrix, based on random matrix, the index weights can be obtained directly.

Combination Weighting Based on Subject and Object Minimize the Sum of Squared Deviations

Assuming: there are two evaluation methods (the low-carbon development level of lead and zinc industry), including Entropy evaluation method and ANP evaluation methods (k = 1 on behalf of Entropy method, k = 2 on behalf of ANP method, the following representatives the same meaning), and the various weight vectors is W1 and W_2 in the two methods, there are:

$$W_1 = \left(w_1^{(1)}, w_2^{(1)}, \dots, w_n^{(1)}\right)^T, \quad W_2 = \left(w_1^{(2)}, w_2^{(2)}, \dots, w_n^{(2)}\right)^T$$

The weight vector of the deviation is:

$$W_0 - W_1 = \left(w_1^{(0)} - w_1^{(1)}, w_2^{(0)} - w_2^{(1)}, \dots w_n^{(0)} - w_n^{(1)}\right)^T$$

$$W_0 - W_2 = \left(w_1^{(0)} - w_1^{(2)}, w_2^{(0)} - w_2^{(2)}, \dots w_n^{(0)} - w_n^{(2)}\right)^T$$

Method Based on Entropy-ANP is constructed to minimize deviation portfolio optimization model:

$$\begin{cases} \min \sum_{k=1}^{2} \left\| W_o - W_k \right\|^2 = \min \sum_{k=1}^{2} \sum_{i=1}^{n} \left(w_i^{(0)} - w_i^{(k)} \right)^2 \\ s.t. \sum_{i=1}^{n} w_i^{(0)} = 1 \end{cases}$$

Equations based on Lagrange multiplier method, the only available solution of the model:

$$w_i^{(0)} = \frac{1}{2} \sum_{k=1}^{2} w_i^{(k)} + \frac{1}{n} \left[1 - \frac{1}{2} \sum_{i=1}^{n} \sum_{k=1}^{2} w_i^{(k)} \right],$$

and i = 1, 2, 3... n ,To i = 1, 2, 3... n, respectively, substituted into the above equation, the optimal combination of weights can be given by ANP method and Entropy Method.

Establishing Comprehensive Evaluation Model based on Two Fuzzy Layers

Establishing the factor set U and the evaluation factors set V about the low-carbon development level of lead and zinc industry.

Establishing weight of the factors set A, A_i

The first level of factors set is A, then there is: A = (a_1, a_2... a_m), in which, $\sum_{i=1}^{n} a_i = 1$;

The second level of factors set is A_i, there are: A_i = (a_{i1}, a_{i2}, a_{in}), in which, $\sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij} = 1$

For the determination of the weight set, there are many methods, such as weight method, variation coefficient, multiple correlation coefficient, etc., where Entropy-ANP-SSD method was used , the specific steps has already been discussed.

Establishing a single factor fuzzy evaluation matrix R ~ i

Assuming: r_{ijk} is membership and its formula is:

rijk = (the number who judges uij is V_k) / (the total number who participated in), where k = 1, 2,3,4,5. If we assume n is the number of elements contained in U_i, m is the number of elements in set V, the fuzzy evaluation matrix R ~ i can be expressed as:

$$R_i = \begin{bmatrix} r_{i11} & r_{i12} & r_{i13} & r_{i14} & r_{i15} \\ r_{i21} & r_{i22} & r_{i23} & r_{i24} & r_{i25} \\ r_{i31} & r_{i32} & r_{i33} & r_{i34} & r_{i35} \\ r_{i41} & r_{i42} & r_{i43} & r_{i44} & r_{i45} \\ r_{i51} & r_{i52} & r_{i53} & r_{i54} & r_{i55} \end{bmatrix}$$

Calculating fuzzy comprehensive evaluation set

According to Ai and R ~ i, we can draw fuzzy comprehensive evaluation set R:

$$R_i = \begin{bmatrix} B_1 \\ B_2 \\ \cdots \\ B_n \end{bmatrix} = \begin{bmatrix} A_1 R_1 \\ A_2 R_2 \\ \cdots \\ A_n R_n \end{bmatrix} = \left[b_{ik} \right]_{m\times n}$$

The first fuzzy comprehensive evaluation set is:

$$R_i = AR = A \begin{bmatrix} B_1 \\ B_2 \\ \cdots \\ B_n \end{bmatrix} = \left[b_1, b_2, \ldots, b_n \right]$$

Where bk= V [ai∧rik], (k= 1, 2, 3, 4, 5)

Obtaining the results of low-carbon development level about lead-zinc industry.

Empirical Research----Taking Intelligent Logistics Industry in Hunan as Example

Strategic emerging intelligent logistics industry further improves the degree of industrial IT application and the industrial chain integration on the basis of the traditional logistics industry development.

TABLE 1 STATISTICS OF HUNAN STRATEGIC EMERGING INTELLIGENT LOGISTICS INDUSTRY OVERFLOWS EFFECT EVALUATION

Target levels	First level indic -ator	A	Second level Indicator	A_i	r_{ij1}	r_{ij2}	r_{ij3}	r_{ij4}	r_{ij5}
Evalu-ation On the over-flow effect of strate-gic em-Erging indu-stry U	Emerg-ing techn-Ology over-flow	0.14	The protection consciousness of intellectual property rights	0.37	0.1	0.2	0.3	0.3	0.1
			The difficulty degree of technology imitation	0.38	0.0	0.3	0.1	0.3	0.3
			Technology integration index	0.13	0.1	0.3	0.3	0.2	0.1
			technology gap among Adjacent enterprises	0.12	0.1	0.2	0.3	0.3	0.1
			Creative technology stock						
			Technological similarity						
	Human resour-ce and capital over-flow	0.14	protection degree of enterprise human resources	0.04	0.1	0.2	0.2	0.2	0.3
			Labor market maturity	0.20	0.1	0.2	0.2	0.3	0.2
			Production persistence accumulate ability	0.24	0.1	0.1	0.3	0.3	0.2
	market over-flow	0.0 9	Products market demand influence coefficient	0.45	0.2	0.3	0.3	0.1	0.1
			Competition environment	0.55	0.3	0.3	0.2	0.3	0. 0
			Economies scope breadth						
			Market monopoly power						
			Factor market demand induction coefficient						
	Innov-ation over-flow	0.08	innovation network importance	0.26	0.1	0.1	0.2	0.3	0.3
			Innovation network stability	0.29	0.1	0.3	0.3	0.2	0.1
			Innovation network reliability	0.22	0.1	0.2	0.3	0.2	0.2
			Innovation network reciprocity	0.23	0.1	0.1	0.2	0.4	0. 2
	Mana-gement knowl-edge and skill over-flow	0.11	Influence coefficient	0.21	0.2	0.3	0.3	0.1	0.1
			Induction coefficient	0.24	0.1	0.2	0.3	0.2	0.2
			Spatial distance	0.28	0.1	0.3	0.3	0.2	0.1
			Management experience	0.27	0.1	0.2	0.3	0.3	0.1
			Skills exchange density						
			absorptive capacity to the outside world knowledge						
			application ability to the outside world knowledge						

It is a product of the combination, development and perfection of the modern production and operation management and information technology integration. It makes the society and enterprise logistics organically combined together, interconnects the production, transportation, warehousing, distribution, loading and unloading, handling and packaging and logistics activities, achieving the automation, informatization, networking and intellectualization of the development of the logistics industry.

According to the "State Council' decisions on speeding up the cultivation and development of Strategic Emerging Automation Industry " and relevant documents wrote by He Xionglang, He Zhengchu , Wen Xianming and some empirical investigation and research of our research group, we have confirmed the Strategic Emerging Automation Industry overflow effect evaluation index system, then through the use of "RSA-ANP-SSD "method to calculate weighing, we have obtained the related data of first level indicator weight A, and the second level indicator weight Ai, they are shown in table1.Then 10 people of the evaluation group use the Delphi method to obtain membership R_{ijk} (where k =1,2,3,4,5), the data are shown in table 1.

Corresponding to the above data, there are:

A= (0.14,0.14,0.09,0.08,0.11,0.07,0.13,0.11,0.13), A_1=(0.37,0.38,0.13,0.12),

A_2= (0.04,0.20,0.24,0.21,0.06,0.21,0.04),

A_3=(0.45,0.55),

A_4=(0.26,0.29,0.22,0.23),

A_5=(0.21,0.24,0.28,0.27),

A_6=(0.62,0.58),

A_7=(0.25,0.24,0.26,0.25),

A_8= (0.20,0.24,0.24,0.20,0.12),

A_9= (0.05,0.20,0.20,0.25,0.05,0.22,0.03).

By the membership of the Rijk and its calculation formula, we get R_1, R_2, R_3, R_4 and R_5, R_6, R_7, R_8, R_9, combined with the formula of calculating R, we can get R and B, the specific calculation procedure is as follows:

m=1, 2, 3,4,5,6,7,8,9. After calculation, we can get the size of the first level fuzzy comprehensive evaluation set B:

$$B = A \cdot R = [0.1681, 0.2456, 0.2455, 0.2370, 0.0858]$$

B is the Strategic Emerging Automation Industry spillover effect comprehensive evaluation results in this area, in order to quantize the elements of the evaluation value V , suppose $V_1=10$, $V_2=20$, $V_3=30$, $V_4=40$, $V_5=50$, V= (10,20,30,40,50), then the evaluation results are weighted, then:

$$V = 0.1681 \times 10 + 0.2456 \times 20 + 0.2455 \times 30 + 0.2370 \times 40 + 0.0858 \times 50 = 27.728$$

Conclusion analysis:

From the above data, we can see that V =27.728 < 30, because $V_3=30$ represents the middle level, therefore, it shows the evaluation value of Hunan strategic emerging intelligent logistics industry spillover effect is at lower middle level.

In the face of the current development situation, in order to improve the Hunan Strategic Emerging Automation Industry spillover effect level, it is a must to keep in line with our nation's emerging industry development policies, to give full play to the leading role and late dominant position of those core enterprises that around Chang-Zhu-Tan city group based on the actual situation of Hunan Province strategic emerging automation industries, to improve traditional industry's transformation ability and the development ability to emerging industry, to push the rapid transformation and development of Hunan modern logistics enterprises. Specific measures should follow three aspects:

First, renew conception, strengthen the pillar position of the modern logistics industry, push the development of 3PL, 4PL, and improve the human resource stock of the intelligent logistics professional talents, increase human capital overflow. From the overall intelligent logistics industry, the technology overflow absorptive capacity can be enhanced and the positive effect of knowledge and technology overflow can be given full play only by improving the level of human resource and capital level. As to the microcosmic logistics enterprises, the stock of corresponding technology professional talents within the enterprises is a key factor that decides enterprises' absorption ability, and it has a direct impact on enterprises absorption effects of the introduction of special technologies. It also influences the transformation of the absorptive technology to practical products, and to the benefit of the enterprises. At the same time, talents stock institute the quantity and quality of human resources in the whole country (region), playing a very important role in promoting the overall technology spillover.

Second, improve the R&D absorption capability; implement different opening policy; increase innovation spillover and emerging technology spillover. In order to improve enterprise's absorptive capacity, it is necessary to improve the enterprise technological innovation system, to strengthen enterprise' independent research and development capacity, to promote cooperation between home enterprises and those foreign enterprises that have a high level of technology, and research & development institutions. Implement different opening policy. As to the industries with higher absorption ability, they can take the opening policy. As to high-tech industry, the market decline of the domestic sectors and the loss of talented people will cause reverse technology diffusion to foreign-funded enterprises, so the high-tech industry should adopt a gradual opening policy, increase innovation spillover and emerging technology spillover.

Third, establish a good system environment that is conducive to the competitiveness and independent research and development of the enterprises, increase the market overflow and management knowledge and skills overflow. The first, gradually establish innovation support system and innovation risk mechanism, encourage entrepreneurship, increase the skills overflow of the intelligent logistics; The second, Further eliminate the barrier of system and mechanism, break industry and market forestall, creating all kinds of enterprises fair competition environment, increase the intelligent logistics enterprises market spillover; The third, Establish a mechanism that enterprises lead the implementation of the national significant science and technology project; provide socialized and commercialized services for all types of enterprises innovation activities, increase management knowledge spillover.

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